4 ICT and changes in selected indicators of international competitive position (based on the example of European Union member states)

Introduction

The recent information revolution that is associated with the development of the Internet and information and communication technologies (ICTs) may be compared to the deep socio-economic changes caused by the spread of railways and electrical grids in the 19th and 20th centuries. The similarity lies in the fact that both phenomena have resulted from the introduction of novel infrastructural networks that fundamentally changed the paradigms of the global economy. In the 19th century, the railways and universal access to electricity at first deepened competitive inequalities. The first beneficiaries of those inventions gained a significant advantage over those who initially did not have access to the rail network or could not increase the scale and efficiency of production through the use of electricity. However, with the spread of innovation and the rapid progressive expansion of railway networks and electrical grids, the initial advantage diminished, which meant new ways had to be found to build national and international competitive position.

The development of ICT since the late 20th century has undoubtedly been a factor, which created a similar competitive edge, evidenced by the rapid development of global technology companies such as Google, Apple, Amazon, and Facebook. However, this advantage may also shrink in the future due to the increasing availability of ICT infrastructure. Therefore, the purpose of this paper was to analyze the changing role of ICT and its impact on the international competitiveness of the European Union member states. To this end, data on telecommunication and computer technologies had been used to calculate the cumulative ICT indicator, which was then compared with the selected measures of the international competitive position, e.g. high-technology exports as a percentage of manufactured exports, efficiency of R&D activities, and expenditures on

R&D as a GDP percentage. Statistical data from the period 1995–2015 (published by Eurostat and some international organizations, such as the World Bank, UNCTAD, WIPO, ITU, and OECD) have been analyzed. This paper uses the methods of descriptive analysis, data normalization, correlation, regression analyses, and Gini coefficients, to highlight the significance of inequality in ICT accessibility on international competitiveness.

1. The development of ICT in the European Union 1995–2015

For decades, we have seen a rapid growth of ICT in economic, political, social, and cultural dimensions. The global availability of the Internet facilitates for example international business contacts, more efficient management and implementation of trade agreements. Moreover, modern methods of data collection, processing, and transmission not only assist in gaining competitive advantage in international markets, but also help to minimize negative economic phenomena.[1]

The indicators in Table 1 show a distinct growth in ICT in the Golden Triad countries (USA, Japan and the European Union) in the years 1995–2015. The only exception was a decrease in the number of subscribers of fixed telephone services, most pronounced in the United States, and less so in the European Union. This decline has probably been due to the change in telecommunications technology over the past two decades, i.e. the development of mobile telephony and services based on wireless networks.

Relatively favorable changes in ICT have also taken place in Central and Eastern Europe (see Table 1). Most of the analyzed indicators have improved even more than in the 'Golden Triad' countries, but mostly due to the low base effect (e.g. in fixed-broadband subscriptions or secure

[1] More on the use of huge data sets to influence the decisions made by consumers see e.g. V. Mayer-Schönberger, K. Cukier, *Big Data: A Revolution that Will Transform how We Live, Work, and Think*, Houghton Mifflin Harcourt, Boston–New York 2013; E. Pariser, *The Filter Bubble: How the New Personalized Web Is Changing What We Read and How We Think*, Penguin Press, New York 2011.

Internet servers). This may suggest that the new EU member states from Central and Eastern Europe have not missed the opportunities offered by the Internet and the digital revolution, with dynamics of change and technological solutions similar to the developed countries. This is confirmed by the exceptionally high saturation of the mobile market in Poland, high broadband Internet access in the Czech Republic and Hungary, or the very high proportion of Internet users (in the Czech Republic and Slovakia, higher than in the United States).

Table 1
Main indicators of ICT development in selected countries in period 1995–2015

Economy	Mobile-cellular telephone subscriptions per 100 inhabitants		Percentage of individuals using the Internet		Fixed-broadband subscriptions per 100 inhabitants		Secure Internet servers (per 1 million people)		Fixed telephone subscriptions (per 100 people)	
	1995	2015	1995	2015	2000	2015	2001	2015	1995	2015
US	13	118	9	75	2	32	274	1,650	60	38
Japan	9	125	2	93	1	30	41	971	50	50
EU-28	5	124	2	79	1	30	44	991	39	34
Poland	0	149	1	68	0[a]	19	9	547	15	11
Czech Rep.	0	129	1	81	0	28	27	867	24	18
Hungary	3	119	1	73	0	27	12	366	21	31
Slovakia	0	122	1	85	0[b]	23	15	393	21	16

[a] 2001 data.
[b] 2002 data.

Source: World Bank, http://databank.worldbank.org/data/home.aspx (accessed 11.09.2016); International Telecommunication Union, http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx (accessed 11.09.2016).

However, in recent years the ICT convergence rate between the new and old EU member states, Japan and the United States, has started to slow down. Data in Table 2 show, that in 2010–2015 the developed countries improved their ranks in the ICT Development Index ranking (in particular the UK, Spain, Germany and Belgium). The new EU member states have mostly seen their rank drop – Poland by 12, Cyprus by 9,

Slovakia and Hungary by 7, and Slovenia by 6 places. On the other hand, all countries included in Table 2 have recorded a significant improvement in IDI value in nominal terms, with the smallest increase at the top of the ranking (especially in the Nordic countries), and among the new EU member states – in Poland and Slovenia. This indicates that other countries (especially developing ones) have improved their innovativeness and as a result the disparities between developed and developing countries have been gradually decreasing[2].

Table 2

ICT Development Index (IDI) ranking in 2010 and 2015 for EU countries, the United States and Japan

Economy	IDI 2015 Rank	IDI 2015 Value	IDI 2010 Rank	IDI 2010 Value	Rank change	IDI value change (%)
1	2	3	4	5	6	7
Denmark	2	8.88	4	8.18	+2	8.6
United Kingdom	4	8.75	10	7.62	+6	14.8
Sweden	5	8.67	2	8.43	–3	2.8
Luxembourg	6	8.59	8	7.82	+2	9.8
Netherlands	8	8.53	7	7.82	–1	9.1
Japan	11	8.47	9	7.73	–2	9.6
Finland	12	8.36	6	7.96	–6	5.0
Germany	14	8.22	17	7.28	+3	12.9
United States	15	8.19	16	7.30	+1	12.2
France	17	8.12	18	7.22	+1	12.5
Estonia	20	8.05	25	6.70	+5	20.1
Belgium	21	7.88	24	6.76	+3	16.6
Ireland	22	7.82	20	7.04	–2	11.1
Austria	25	7.67	23	6.90	–2	11.2
Spain	26	7.66	30	6.53	+4	17.3
Malta	30	7.52	28	6.67	–2	12.7

[2] In the IDI 2015 ranking the first position was hold by South Korea, 9th place by Hong Kong, and Poland with the 44th place was preceded by Belarus (36th place). The list included 167 countries, with 22 out of 34 developed countries (according to the World Bank classification) falling in the ranking, with 60 out of the remaining countries improved their position (e.g. Costa Rica, Bahrain, Lebanon, Ghana and United Arab Emirates) (see *Measuring the Information Society Report 2015*, International Telecommunication Union, Geneva 2015, p. 46).

1	2	3	4	5	6	7
Slovenia	33	7.23	27	6.69	–6	8.1
Czech Rep.	34	7.21	33	6.30	–1	14.4
Latvia	37	7.16	34	6.22	–3	15.1
Italy	38	7.12	31	6.38	–7	11.6
Greece	39	7.09	35	6.20	–4	14.4
Lithuania	40	7.08	39	6.02	–1	17.6
Croatia	42	7.00	42	5.82	0	20.3
Portugal	43	6.93	36	6.15	–7	12.7
Poland	44	6.91	32	6.38	–12	8.3
Slovakia	47	6.82	40	5.96	–7	14.4
Hungary	48	6.82	41	5.92	–7	15.2
Bulgaria	50	6.52	47	5.45	–3	19.6
Cyprus	53	6.37	44	5.75	–9	10.8
Romania	59	6.11	55	4.99	–4	22.4

Source: own calculations based on ITU data, http://www.itu.int/net4/ITU-D/idi/2015/# (accessed 22.09.2016).

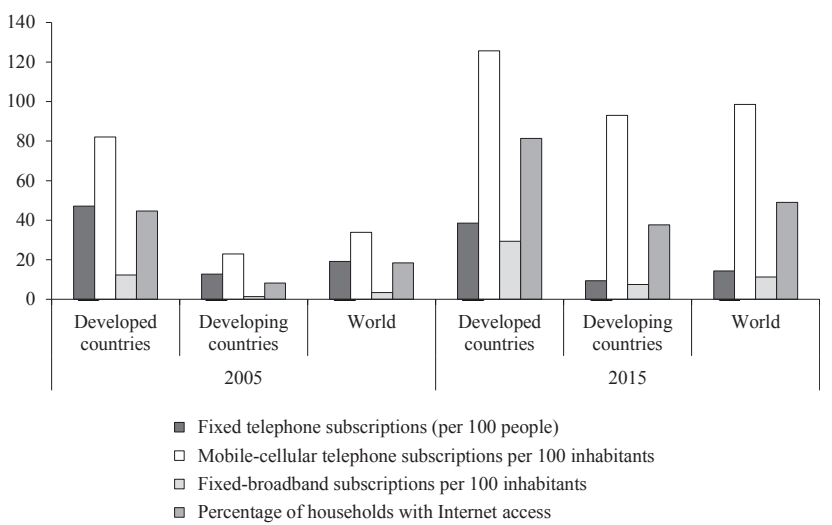

Figure 1. Selected ICT development indicators for country groups in 2005 and 2015

Source: own preparation based on *ITU World Telecommunication/ICT Indicators*, http://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx (accessed 22.09.2016).

The aforementioned phenomenon is to some extent presented in Figure 1. In the period 2005–2015 the largest disparity decrease between developed and developing countries occurred in relation to the number of mobile subscriptions per 100 inhabitants and percentage of households with Internet access. In the case of the number of fixed telephone subscriptions, the difference between the two groups of countries has remained almost the same, which confirms the declining importance of fixed telephony in today's telecommunications market.

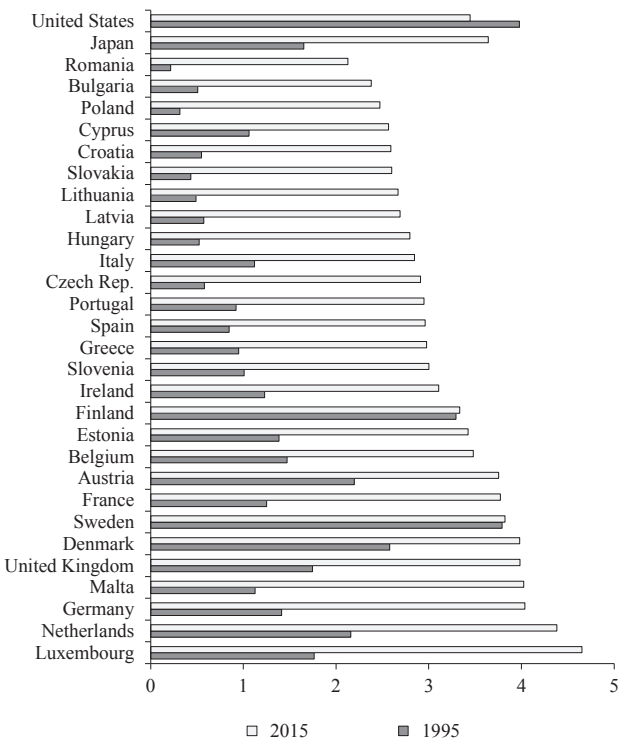

Figure 2. Summary ICT development index for EU countries, the United States and Japan in 1995 and 2015

Source: own calculations and presentation based on *ITU World Telecommunication/ICT Indicators*…; World Bank…

Indicators in Table 1 are presented as normalized values to enable the calculation of cumulative (summary) ICT development indicator in the period 1995–2015 for the European Union member states, the United States, and Japan. The results for extreme years are presented in Figure 2 (maximum value = 5), ordered according to data from 2015. The most important change in ICT, that has taken place at the forefront of the EU countries, has been the convergence between the countries of Western Europe and the previous leaders – the Scandinavian countries. The measured ICT growth in some European countries has been higher than in Japan and the United States (in the latter one a significant deceleration can be observed compared to 1995).

With regard to the new EU member states, we can see the convergence of ICT in the analyzed period (with the range of 2.0 to 3.0). The technological leap has been especially distinct in Malta, Estonia and Slovenia, which have not only overtaken the crisis-stricken countries of southern Europe (Greece, Portugal, Spain, Italy), but also found themselves at the forefront of Europe in ICT development (Malta and Estonia). Unfortunately, the position of Poland in this area has not improved significantly. In spite of a certain convergence, Poland was in third place from the end in 2015, ahead only of Bulgaria and Romania (in 1995 just ahead of Romania). In general, the data indicate a positive trend of convergence in ICT development in the EU over the last two decades, but the leaders have not changed – those are the Scandinavian countries and the countries of the "old" EU.

The aforementioned considerations are summarized in Figure 3, showing the Gini coefficient for EU in the period 1995–2015, here used to show the uneven development of ICT. As previously shown, an evident decrease in disparities between the member states concerning the first three indicators, i.e. the number of mobile subscriptions per 100 inhabitants, the percentage of Internet users and the number of fixed broadband subscriptions (also reflected in the summary ICT development indicator) can be noticed. The values of the Gini coefficient for the remaining two indices are almost unchanged, although a value over 0.4 in the case of the number of secure Internet servers may suggest the existence of certain

disparities, especially between the countries of the 'new' and 'old' European Union.

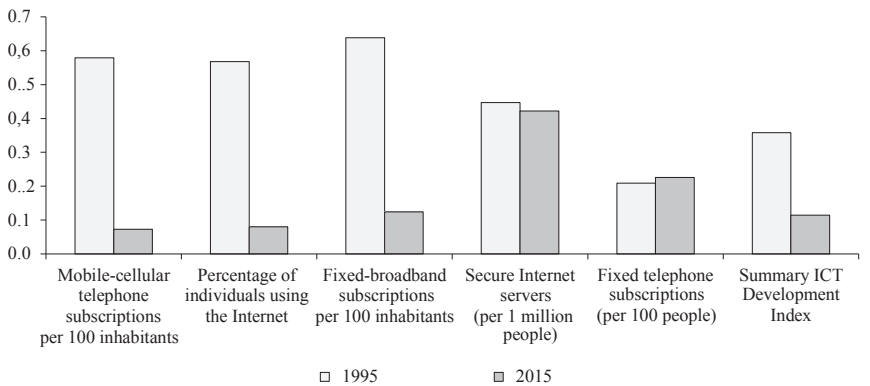

Figure 3. Gini coefficient values of ICT development inequality in European Union countries in 1995 and 2015

Source: as in Figure 2.

2. The development of ICT and selected measures of international competitiveness

Similar to radical innovations during the industrial revolution, modern information and communication technologies play an important role in shaping the future direction of the global economy progress. In the 1980s and 1990s, countries that were at the forefront of the digital revolution, in particular the United States, achieved a significant competitive advantage over the rest of the world. However, it remains an open question whether this advantage related to the access to ICT is permanent[3].

[3] More on the changes associated with the development of ICT see in N. Carr, *The Big Switch: Rewiring the World, from Edison to Google*, W.W. Norton & Company, New York–London 2009, p. 9 and next; N.G. Carr, *Does IT Matter? Information Technology and the Corrosion of Competitive Advantage*, Harvard Business School Press, Boston 2004, p. 13 and next.

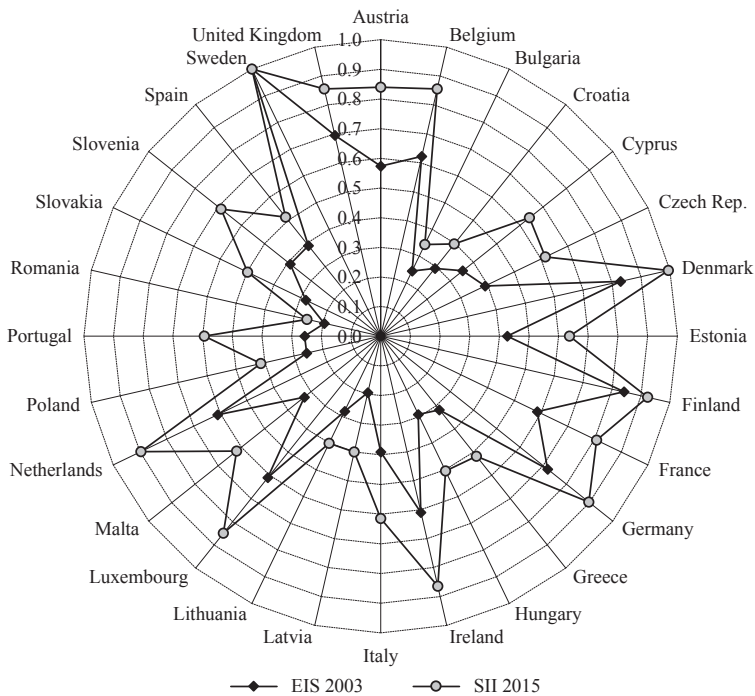

Figure 4. Comparison of *European Innovation Scoreboard* (EIS) 2003 and *Summary Innovation Index* (SII) 2015 for 28 EU member states (normalized values)

Source: own calculations and presentation based on European Commission data, http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_pl (accessed 16.09.2016).

The international competitive position is inextricably linked with the level of innovation in the economy.[4] Therefore, Figure 4 shows a compar-

[4] More on the international competitiveness and its indices, see e.g. M. Gorynia, *Międzynarodowa konkurencyjność polskiej gospodarki a polityka ekonomiczna*, "Ekonomista" 1996, No. 3; J. Misala, *Istota i mierniki międzynarodowej konkurencyjności gospodarki*, Instytut Gospodarki Światowej, SGH, Warszawa 2000; M.J. Radło, *Międzynarodowa konkurencyjność gospodarki. Uwagi na temat definicji, czynników i miar*, in: W. Bieńkowski et al., *Czynniki i miary międzynarodowej konkurencyjności gospodarki w kontekście globalizacji – wstępne wyniki badań*,

ison published by the European Commission of the 2003 synthetic innovation indicators EIS and SII. In the examined, a relatively short period the innovation of EU member states undoubtedly improved, moreover, decreasing disparity between them in relation to the level of innovation (the Gini coefficient for EIS 2003 was 0.253, while for SII 2015 it was 0.1825) can be noticed.[5] The countries that saw the greatest improvement in terms of innovation, were Portugal, Slovenia, the Netherlands, Malta and Cyprus, while the smallest increases occurred in Sweden, Finland, Romania, Bulgaria and Croatia. As can be seen, those changes are quite similar to the previous analysis of ICT development.

The technological factor is one of the most important determinants of contemporary international competitiveness, and therefore three measures reflecting the innovativeness and the degree of technological sophistication of the economy have been selected, namely the expenditures on R&D, the share of high technology exports, and the efficiency of R&D activities.[6] Figures 5a, 5b, and 5c present the spread between the ICT development index and the aforementioned measures for the European Union, the United States, and Japan. In all cases, there was a positive correlation between the studied variables, the highest between the development of ICT and expenditure on R&D, and R&D efficiency. Moreover, comparing the charts for each year, Pearson correlation coefficients increased for HTEX (from 0.388 in 1995 to 0.507 in 2015) and INTPR (from 0.605 in 1995 to 0.724 in 2014). Although the correlation between the development of ICT and expenditure on R&D fell from 0.798 in 1996 to 0.596 in 2015, this should have been still assumed as a quite strong positive correlation.

Prace i Materiały Instytutu Gospodarki Światowej, Warszawa 2008, No. 284, p. 4 and next.

[5] Own calculations based on the data of the European Commission, http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_pl (accessed 16.09. 2016).

[6] Analysis of R&D efficiency uses e.g. the number of granted patents per million inhabitants, but for the sake of this paper a more complex indicator has been used, i.e. the total number of registered patents, trademarks and industrial designs per million inhabitants.

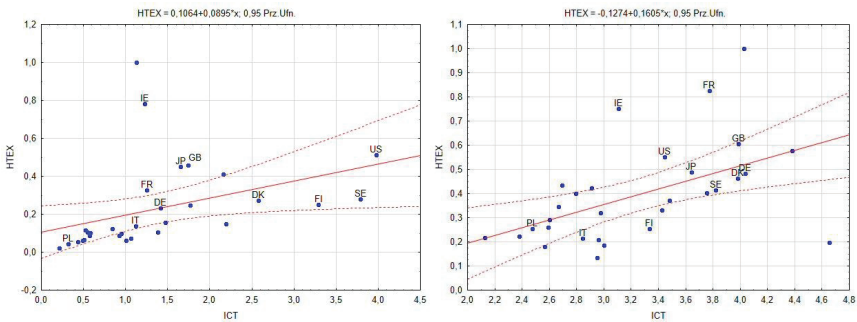

Figure 5a. Scatter plots between ICT development index (ICT) and high--technology exports (as % of manufactured exports) (HTEX) in 1995 (left chart) and 2015 (right chart)

Source: own calculations and presentation based on the following data: World Bank…; International Telecommunication Union…; World Intellectual Property Organization, http://ipstats.wipo.int/ipstatv2/index.htm (accessed 20.09.2016); UNCTAD, http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx (accessed 20.09.2016) and Eurostat, http://ec.europa.eu/eurostat/web/science-technology-innovation/data/main-tables (accessed 11.09. 2016).

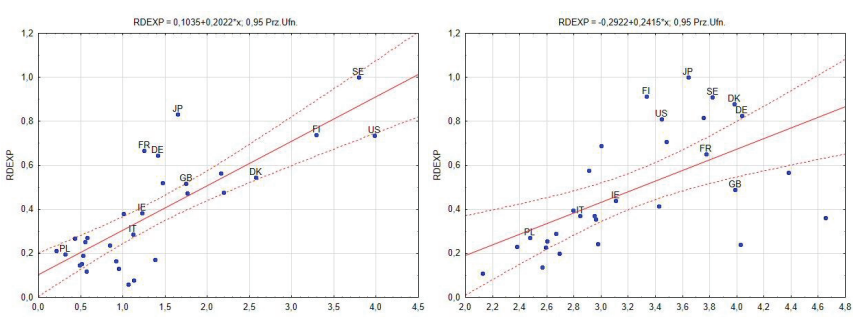

Figure 5b. Scatter plots between ICT development index (ICT) and research and development expenditure (as % of GDP) (RDEXP) in 1996 (left chart) and 2015 (right chart)

Source: as in Figure 5a.

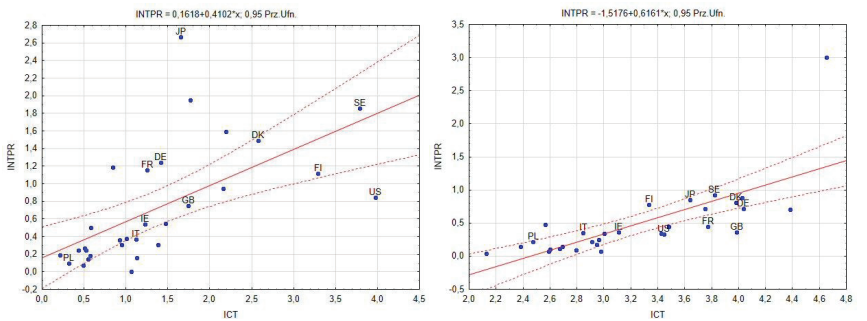

Figure 5c. Scatter plots between ICT development index (ICT) and research and development efficiency index (INTPR) in 1995 (left chart) and 2014 (right chart)

Source: as in Figure 5a.

Conclusions

The data analysis allows to formulate the following general conclusions:

1. The analyzed period saw a convergence of information and communication technologies within the EU, as evidenced by the low value of the Gini coefficient. Many EU member states, in particular the Scandinavian countries, and also some new member states, have caught up with the previous leaders, such as the United States or Japan.
2. Despite the passage of several decades since the beginning of the digital revolution, a high correlation still exists between the development of ICT indicators and international competitive position, in particular the share of high-technology exports and R&D efficiency.
3. The continuing importance of ICT in shaping the international competitive position may in part be due to a lack of adequate data to carry out more detailed analyses. Other difficulties include a too short study period and the impact of the global economic crisis of 2008–2009 (occurred roughly in the middle of the period, and

undoubtedly affected the indicator values in subsequent years, especially those relating to the international competitive position).

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